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# GRAPHITE DEPOSITS ON THE NORTH SIDE OF THE KIGLUAIK MOUNTAINS, SEWARD PENINSULA, ALASKA.

By

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## INTRODUCTION

The graphite deposits on the north side of the Kigluaik Mountains have been known for many years, and have yielded a small quantity of flake graphite, but they have been only slightly developed. The author spent 4 days of June 1943 in company with Mr. H. E. Heide, mining engineer of the Bureau of Mines, and Mr. Norman Tweet, part owner of one of the properties. Acknowledgment is due Mr. John Read and the Lomen Commercial Company for many favors rendered in connection with the investigation. The chemical analyses in this report were made by F. S. Grimaldi, of the Geological Survey.

The deposits were examined many years ago by Harrington 1/ who discussed the general geology and described the developments up to the date of his examination. Much of the history of the district given below is taken from his report.

According to Harrington, the first claims were staked in 1900. Two principal groups of claims were worked, those of the Uncle Sam Alaska Mining Syndicate and those of the Alaska Graphite Mining Company.

Harrington records that the claims of the Alaska Graphite Mining Company were staked in part in 1905 and in part in 1915 or 1916. A production of 35 tons picked from talus was reported for 1907. According to Mertie, 2/ the production in 1916 was about 100 tons, which according to Harrington, was shipped in 1917, together with several tons mined from an open cut in that year.

In 1912, according to Mertie, shipments totalling 130 tons of graphite were made by the Uncle Sam Alaska Mining Syndicate, and 300 tons were ready for

1/ Harrington, G. L., Graphite mining in Seward Peninsula: U. S. Geol. Survey Bull. 692, pp. 363-367, 1919.

2/ Mertie, J. B., Jr., Lode mining and prospecting on Seward Peninsula: U. S. Geol. Survey Bull. 662, pp. 448-449, 1918.

shipment in 1916. Harrington, who visited the area in 1917, reported that no shipments were made in that year by that company.

No records of subsequent production have been found. The properties apparently lay dormant until the summer of 1943, when renewed interest was expressed in the restaking of claims.

Graphite deposits are widespread in the Kigluaik Mountains. 3/ The deposits described in the report have received the most attention because of their relative accessibility. These deposits are about 36 miles northwest of Nome and about 26 miles east of Teller (see fig. 1). The principal deposits are 2 to 3 miles from an arm of the Imuruk Basin, and about 27 miles by salt water from Teller. Most of the Imuruk Basin is shallow and does not exceed a fathom in depth at distances as much as a mile from shore. Arrangements may be made at Teller to charter small boats for the trip to the graphite-bearing area.

The portion of the area between the Kigluaik Mountains and the Imuruk Basin (see fig. 2) is chiefly a gently-sloping alluvial fan, in which the larger creeks are intrenched from 10 to 30 feet near the mountain front.

The creek herein called Graphite Creek, the northeasternmost creek shown on figure 2, is about 2 miles southwest of the Cobblestone River. Ruby, Ptarmigan and Trail Creeks transect the mountain front in the order named, proceeding southwestward from Glacier Creek. Farther to the southwest, some of the smaller creeks are unnamed. The creek about 1.4 miles southwest of Trail Creek is herein called Christophosen Creek in order to have a convenient means of reference.

## GENERAL GEOLOGY

The graphite deposits on the north side of the Kigluaik Mountains are in a sequence of quartzite schists, gneisses and marble which forms the abrupt north front of the rugged Kigluaik Mountains. These rocks are regarded 4/ as Paleozoic or earlier in age. In the area described in this report they are intruded by a few sills and dikes of granodiorite aplite, olivine basalt, and other igneous rocks.

The area between the mountain front and the Imuruk Basin is underlain by coarse alluvium composed of subangular fragments of the various rocks that crop out in the mountains. Locally, the unconsolidated alluvium has been trenched deeply enough by the streams to expose a fanglomerate, made up of material similar to that

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3/ Moffit, F. H., Geology of the Nome and Grand Central quadrangles, Alaska: U. S. Geol. Survey Bull. 533, pp. 135, 136, 1913.

4/ Moffit, F. H., Geology of the Nome and Grand Central quadrangles, Alaska: U. S. Geol. Survey Bull. 533, p. 23, 1913.
Smith, P. S., Areal geology of Alaska: U. S. Geol. Survey Prof. Paper 192, p. 10, 1939.

of the alluvium and cemented by limonite. The fanglomerate evidently is also derived from the rocks of the mountains.

The surface boundary between the ancient metamorphic rocks and the young alluvium and fanglomerite is, for a distance of several miles, a nearly straight or gently curving line which also marks the base of the steep mountain front. This boundary is a fault of large displacement which, in the area mapped, trends about N. 75° E, and where exposed (see fig. 2) dips 44° N. to 74° N. The banding and schistosity of the metamorphic rocks in general strike from N. 60° W. to N. 80° W. and dip from 35° NE. to 60° NE.

Sillimanite is the characteristic metamorphic mineral in the more siliceous rocks which make up the greater part of the metamorphic sequence. Biotite and garnet are also common, and graphite, amounting locally to several percent of the rock, is widespread. The disseminated graphite flakes range in size from 0.2 mm. to 1 mm. Locally the graphite is intergrown with biotite, but it is common also in the non-micaceous quartzite and gneiss. Graphitic marble is also present but in smaller volume.

Thin quartz monzonite sills apparently intruded the rocks prior to metamorphism. A few quartz-diorite sills apparently were injected during metamorphism. Granodiorite aplite dikes apparently were injected following metemorphism. A few dark dikes of olivine basalt are believed to be the youngest igneous rocks in this area.

## GRAPHITE DEPOSITS

### Distribution of graphite

Most of the graphite in the area studied is a constituent of the metamorphic rocks, being widely disseminated in nearly all types. Zones as much as 25 feet thick in the quartz-biotite-graphite schist and quartz-biotite-garnet-graphite schist contain perhaps as much as 10 percent of graphite. Within these low-grade zones are lenses made up largely of relatively coarse graphite flakes, as much as several millimeters in diameter. The lenses were estimated visually to contain from 50 percent to 90 percent of graphite by volume; the chief impurity is quartz, both milky and glassy. The graphite of the lenses is in part schistose and in many places is much contorted by fault movements, which have followed preferentially the graphitic zones. Faulted lenses appear to contain less flake graphite than undisturbed lenses. In general, the diameter, or exposed length, of the high-grade graphitic lenses appears to be from 10 to 15 times the thickness. The lenses examined may comprise as much as a quarter of the total volume of the graphitic zones of minable dimensions of which they are a part.

All of the graphite which has hitherto been shipped from this area has been obtained either by mining the zones containing the richer lenses and sorting out the richer material, or by collecting the surface float derived from such lenses.

Description of graphite occurrences.

Although graphite is widely distributed along the entire front of the Kigluaik Mountains, the principal properties are the claims once worked by the Uncle Sam Alaska Mining Syndicate, in the vicinity of the creek herein called Christophosen Creek, and the claims worked by the Alaska Graphite Mining Company, in the vicinity of Graphite Creek and Ruby Creek (see fig. 2).

Between Christophosen Creek and the next gully westward are several small piles of sorted graphite, evidently derived either from pits buried by snow at the time of the examination resulting in this report or collected from the talus slopes. Mr. Heide estimated the total amount of graphite in these piles to be about 50 tons. The graphite contents, as shown by chemical analyses, of several screen-sized fractions of a grab sample from the largest of these piles are as follows:

| | Size of particles (screen size in meshes per inch) | | | | |
|---|---|---|---|---|---|
| | plus 10 | minus 10 plus 30 | minus 30 plus 50 | minus 50 | entire sample |
| Percent of total weight of sample | 63.5 | 19.5 | 6.9 | 10.1 | 100 |
| Percent of graphite | 55.04 | 58.74 | 62.53 | 60.56 | 56.62 (by analysis) 56.83 (by calculation) |

About 200 feet higher than the cabin on Christophosen Creek and 800 feet farther south and a little farther east than it, on the west side of the canyon, is a small pit, which exposes a graphitic lens, enclosed in graphitic quartz-biotite schist. The lens is about 1 foot thick, but its length could not be determined. The graphite content as shown by chemical analyses, of several screen-sized fractions of a specimen of the average material of this lens is as follows:

| | Size of particles (screen size in meshes per inch) | | | | |
|---|---|---|---|---|---|
| | plus 10 | minus 10 plus 30 | minus 30 plus 50 | minus 50 | entire sample |
| Percent of total weight of sample | 63.2 | 19.6 | 6.6 | 10.6 | 100 |
| Percent of graphite | 22.59 | 25.71 | 31.12 | 31.73 | 24.90 (by analysis) 24.73 (by calculation) |

A small pit a few feet south of the fault about 5,500 feet northeasterly along the fault from Christophosen Creek exposes graphitic schist containing, in a thickness of 4 feet, four irregular stringers of high-grade graphite, each from three to four inches thick. Two more similar stringers crop out about three feet stratigraphically below the lowest of the four stringers exposed in the pit.

On the east bank of the creek herein called Trail Creek the fault marking the mountain front is exposed at the base of the scarp, where it trends N. 78° E., and dips 62° NW. The gouge zone, about 18 inches thick, is highly graphitic but only a little good flake graphite was seen.

Ground claimed by N. B. Tweet and sons, of Teller, includes part of the ground formerly worked by the Alaska Graphite Mining Company. The westernmost workings observed are near the frontal fault about 50 feet west of a small gulch about 400 feet west of Ruby Creek. Here two trenches have been extended to form one practically continuous open cut, about 50 feet long, following a graphitic zone in the schist which strikes N 55° W and dips 60° NE. In this zone, lenses of high-grade graphitic material up to 1 foot in thickness form, at least locally, as much as 50 percent of the rock. This high-grade material was estimated to contain at least 70 percent of graphite by volume. The graphite contents, as shown by chemical analyses, of various screen-sized fractions of a sample of the high-grade material from the face of this cut are as follows:

| | Size of particles (screen size in meshes per inch) | | | | |
|---|---|---|---|---|---|
| | plus 10 | minus 10 plus 30 | minus 30 plus 50 | minus 50 | entire sample |
| Percent of total weight of sample | 63.3 | 20.4 | 6.7 | 9.6 | 100 |
| Percent of graphite | 57.58 | 63.06 | 64.28 | 62.07 | 59.73 (by analysis) 59.58 (by calculation) |

The upper end of this cut is about 100 feet higher than the point where Ruby Creek crosses the fault. The graphite zone which the cut develops may be traced southeastward by means of float for 500 feet to a point about 170 feet higher than the cut. The graphitic zones on Ruby Creek, mentioned below are probably stratigraphically above this zone.

On the east bank of Ruby Creek, 20 feet south of the fault, a 20-foot drift in graphitic schist exposes a 4-foot zone between two faults, which trend about N 80° E and dip about 70° NW near the face of the drift. Within the 4-foot zone are several stringers, each from 1 to 6 inches thick, of high-grade graphitic material. The faults locally follow bedding planes, and apparently represent bedding-plane splits from the frontal fault. On the same side of the creek, 180 feet higher, is exposed a graphitic zone about 1½ feet thick, interbedded with garnetiferous schist. About half of the thickness of the 1-½-foot zone is high-grade graphite. Five feet stratigraphically below this zone is a 2-inch bed, and 1 foot farther down in the sequence a 4-inch bed of high-grade material, making a total thickness of 15 inches of high-grade material in an 8-foot zone of graphitic rock.

Seventy feet south of the frontal fault on the same side of Ruby Creek, several high-grade lenses of graphite from 4 inches to 12 inches thick are distributed through a zone about 12 feet thick.

None of the graphite zones exposed along Ruby Creek could be traced more than a score of feet, because of soil cover on the hillside and snow banks in the bottom of the canyon. The individual high-grade lenses are less than 20 feet long and in general seem to be about 12 times as long as they are thick. Although the individual lenses are short, any graphitic zone is believed to contain about the same amount of high-grade material for tens of feet along the strike, the decrease in thickness of one lens being compensated by the increase in thickness of another.

On the west side of Graphite Creek, about 170 feet higher than the point at which the stream crosses the frontal fault, is a pit about 30 feet long on the footwall, and about 8 feet long on the hanging wall, and following the schistosity of the rocks, which coincides with the bedding, and trends about N. 87° W., and dips 49° N. From this pit, according to Mr. Tweet, about 50 tons of graphite was mined and shipped in 1916. The pit was partly filled with snow when it was examined by us, but a 13-foot section was measured across the bedding. Of this section, a total of about 3 feet is highly graphitic, garnetiferous schist, with garnets as much as half an inch across, and about 3½ feet consists of high-grade graphitic material, with numerous irregular quartz stringers. Because the high-grade graphitic material is present in lenses, the thickness of such material in this zone probably would be different a few feet away from the section measured. The results of chemical analyses for graphite content of screen-sized fractions of a sample of the garnetiferous graphitic schist and one of the high-grade graphite from this pit are as follows:

| | Size of particles (screen size in meshes per inch) | | | | |
|---|---|---|---|---|---|
| | plus 10 | minus 10 plus 30 | minus 30 plus 50 | minus 50 | entire sample |
| Percent of total weight of sample of schist | 51.7 | 25.6 | 9.8 | 12.9 | 100 |
| Percent of graphite | 12.80 | 11.18 | 9.10 | 11.80 | 11.97 (by analysis)<br>11.89 (by calculation) |
| Percent of total weight of sample of high-grade graphite | 65.2 | 19.1 | 6.5 | 9.2 | 100 |
| Percent of graphite | 58.58 | 58.08 | 61.90 | 57.82 | 58.64 (by abalysis)<br>58.62 (by calculation) |

On the east side of Graphite Creek, a zone of graphitic material of considerable extent is exposed. It is at least 200 feet across the strike of the beds from the projected position of the zone found in the pit described above, and is stratigraphically above it. Near the bottom of the canyon, this zone is about 25 feet thick. Mr. Heide sampled a 20-foot thickness of the graphitic schist, including some high-grade stringers, but excluding a three-foot lens of high-grade graphitic material at the base of the graphitic zone, and found by a rough analysis a graphite content of about 10 percent. Heide examined some cuts and exposures farther east and reports that about 200 feet east of the place where the sample was taken, and along the same zone, a cut exposes a high-grade graphitic bed about 4 feet thick. Two hundred feet east of this cut, another cut exposes a similar thickness of high-grade material. The graphitic zone can be traced by float for 80 feet beyond the easternmost cut, and by occasional exposures between the cuts. Whether or not the bed of high-grade material is continuous over the whole distance is not known.

## RESERVES

Because of scanty exposures and the consequent uncertainty as to continuity between exposures, the estimation of graphite reserves is highly speculative. The measured reserves include only the 50 tons or so of sorted material already stockpiled.

The data resulting from this examination make possible the inference that there is about 65,000 tons of graphitic material, averaging about 60 percent graphite by volume or about 52 percent by weight, in the three miles of mountain front examined and down to the level of the alluvium in front of the scarp. If material containing as little as 10 percent of graphite can be mined, the reserves may be as much as 2 or 3 million tons. These figures correspond with those arrived at by Mr. Heide.

## SUGGESTIONS TO PROSPECTORS

The development and operation of the graphite deposits of the Kigluaik Mountains would be subject to certain handicaps. Any graphite produced there would have to compete with that now readily available in the major markets and to which the principal users are accustomed. Adverse climatic conditions, short open season, high freight rates, and limited supply of skilled labor would all have to be met. The unweathered state of the graphitic rocks would render crushing necessary, with attendant increase of costs and possible reduction in the size of the graphite flakes. In some regions, graphite is recovered from deeply decayed rocks. Some of the graphite in the Kigluaik Mountains is intimately intergrown with micaceous minerals; because the separation of graphite from such intergrowths is difficult 5/, places should be selected for mining where this intergrowth is not present.

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5/ Miller, B. L., Graphite, in Industrial Minerals and Rocks, p. 344, Am. Inst. Min. Met. Eng., 1937.
Alling, H. L., The Adirondack graphite deposits: New York State Mus. Bull. 199, p. 132, 1918.

The best material sampled in the Kigluaik Mountains is very high-grade in comparison with deposits of flake graphite mined elsewhere; even the poorest material sampled would be good ore in many places. However, it is unlikely that a product usable in industry can be made by sorting alone without mechanical beneficiation. No substantial improvement in grade could be obtained solely by crushing and screening. That graphite of high purity is present is shown by Grimaldi's report that graphite remaining after purification with hydrofluoric and nitric acids is about 98 percent carbon.

As large areas in the Kigluaik Mountains have not yet been studied in detail, the best deposits may not have been found. The impression gained in the course of the investigation was that the deposits are of higher grade in the vicinity of Graphite Creek near the east end of the belt examined than they are farther west. All of the deposits mined thus far are in the metamorphic rocks. The possibility of finding a deposit of "crystalline" graphite of the Ceylon type is suggested by the occurrence, reported by Moffit 6/, of graphite forming an 8-inch layer between pegmatite and schist. Such material might be more valuable than the flake graphite recovered from disseminated deposits in schist.

April 1944

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6/ Moffit, F. H., op. cit., p. 136.

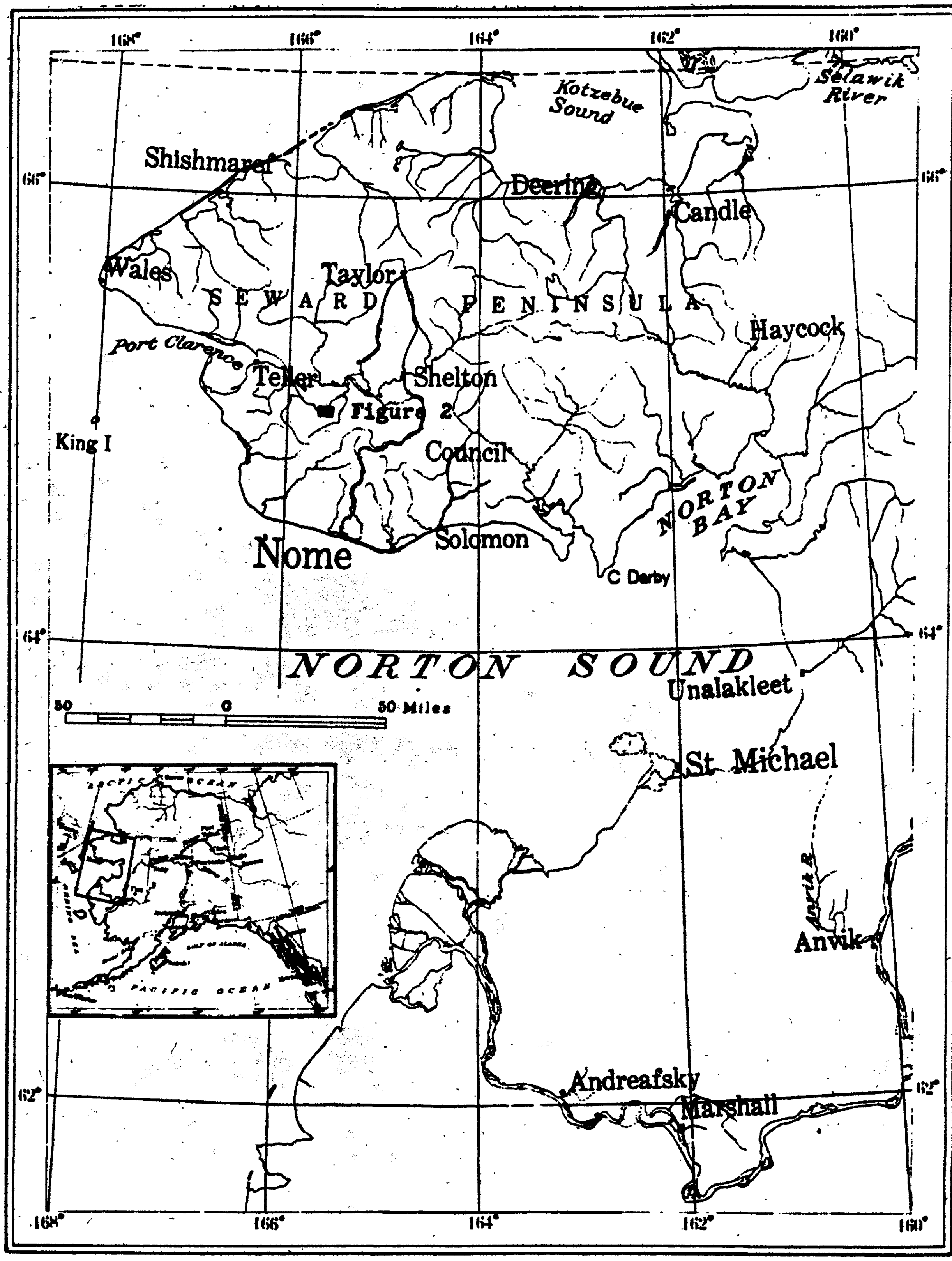


**Figure 1**

**Index map, showing location of area covered by Figure 2**

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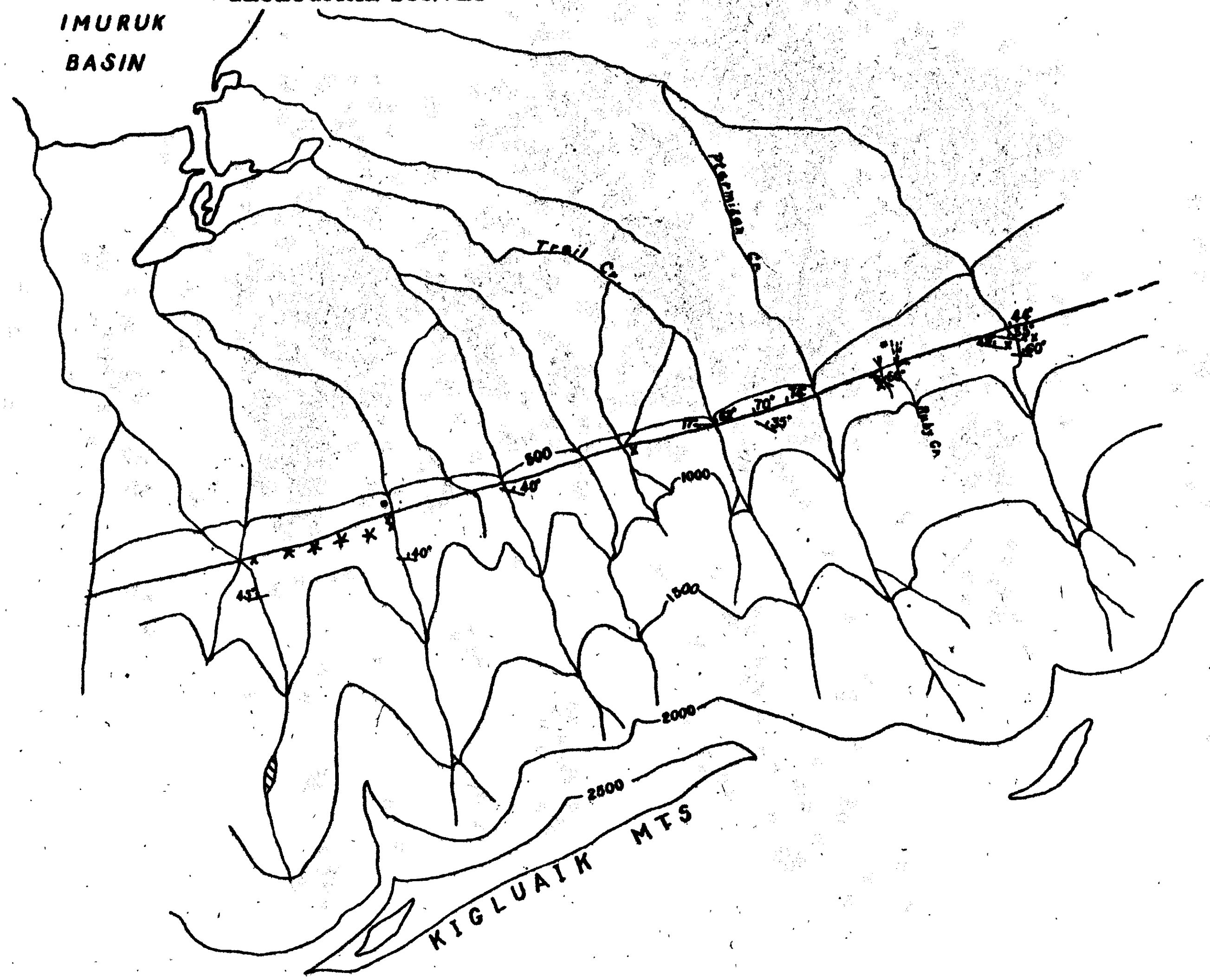
WAR MINERALS INVESTIGATIONS
PRELIMINARY MAP



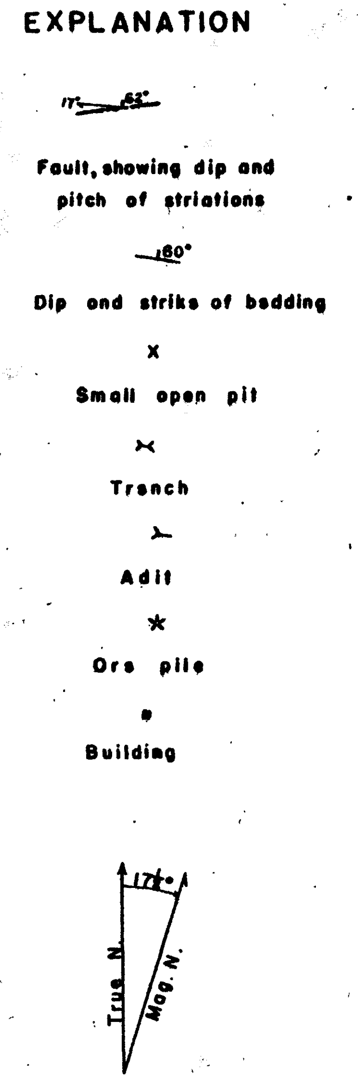




FIGURE 2
TOPOGRAPHIC SKETCH MAP
OF PART OF KIGLUAIK MTS.
SHOWS LOCATION OF GRAPHITE PROSPECTS
Contour interval 500 feet

0 2000 4000 6000 feet

Robert R. Coats, 1943